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**Abstract**

We analyse the conceptions of 322 Polish teachers, related to Environment. They mainly differ from the way some teachers think that animals as snails, flies or frogs can or cannot feel happiness and, independently, from their opinions pro- or anti-GMO. The six samples (primary school teachers, secondary school teachers of biology or of Polish, with for the three pre-service and in-service teachers) have different conceptions, the biology teachers being more pro-GMO. Most of the Polish conceptions are for preservation of environment, but, when compared to 12 other countries (the same teachers' samples), they are more anthropocentric than most of the observed conceptions in the 12 other European countries (except in Lithuania and Finland).

**Key-words**

Environment - Environmental Education - Teachers - Conceptions - GMO - Preservation.

## 1 - Introduction

Wieslaw Stawiński was an active member of the AEDB (Association Européenne de Didactique de la Biologie) during the nineties, an association chaired by Pierre Clément. From this active collaboration born the inclusion of a Polish team, under the responsibility of Elwira Samonek, in an European research project (BIOHEAD-Citizen), coordinated by Pierre Clément and two other colleagues. This project ("Biology, Health and Environmental Education for better Citizenship") involved 19 countries, 6 of them out of Europe, from 2004 to 2008. It was focused on the relations between science and society, through six topics: (1) Environmental Education, (2) Health Education, (3) Human reproduction and Sexuality Education, (4) Evolution and human origins, (5) Human Genetics and (6) Human Brain. Are these topics taught in the same way, with the same scientific content and the same goals, in the 19 countries?

To answer to this question, we analysed the school textbooks dealing with these topics in the 19 countries, and the teachers' conceptions.

Most of our results, presented in Brussels (Carvalho, Clément , Bogner & Caravita, 2008) are not yet published concerning the data gathered in Poland. We present here the main results related to Polish teachers' conceptions on nature, environment and environmental education.

Our theoretical background is the KVP model (Clément 2004a, 2006), to analyse conceptions as possible interactions between three poles: the scientific knowledge (K), values (V) and social practices (P). For the six topics of the project, the taught knowledge is strongly associated with values and social practices. That is particularly truth for the Environmental Education (Clément & Hovart 2000): its goals are not limited to the transmission of (multidisciplinary) knowledge but also involves the students' attitudes and values (Giordan & Souchon 1991, Giolitto & Clary 1994).

Nevertheless, the philosophy of Nature (Quillot 2000) and of Environment (Larrère 1997) shows that several and often divergent values are associated with them (Sauvé 1994, Schultz & Zelezny 1999, Clément 2004b). From a survey of the literature, we defined several axes to analyse the teachers' conceptions related to nature and environment (Forissier & Clément 2003, Caravita et al. 2008). We built a questionnaire taking into account the following points:

* The two poles defined by Wiseman & Bogner (2003) when analysing students' conceptions on environment: utilisation and preservation, which are not very different from the two

classical types of conceptions on Environment: anthropocentred and ecocentred. Several results of the Biobead-Citizen research confirmed the importance of these two poles (Munoz et al. 2009): are we going to find these two poles in the Polish teachers' conceptions? Some other results showed three poles in the teachers' conceptions: anthropocentred (pole utilisation), ecolocentred (pole preservation) and "sentimentocentred" (see the next paragraph).

* This sentimentocentred pole, focused on the capacity of animals to feel dolour or happiness. This pole was very structuring of the teachers' conceptions analysed in France, Portugal and Germany (Forissier 2003, Forissier & Clément 2003), in Lebanon (Khalil et al 2007), in Algeria (Khammar et al 2008) and in Morocco (Khzami et al 2008). What are the Polish teachers' conceptions related to this pole?

* The last point is linked to the GMO, with animated debates inside most of the European countries, generally structured by an opposition vs. acceptation of GMO, French teachers being mostly anti-GMO (Clément *et al.* 2007).

We will analyse the Polish teachers' conceptions and then we will briefly compare them to the 11 other European countries involved in the Biohead-Citizen project.

## 2 - Methods

### *2-1 - Samples*

In Poland, 322 teachers filled out the Biohead-Citizen questionnaire. The six samples are briefly presented in the Table 1. Most of them were catholic (94.1%), very few protestant (0.6%), atheist or agnostic (1.9%). Only 3.4% ticked the item "I don't wish to answer" when answering this question on their own religion.

| **Samples of Polish teachers** | number | Mean age (years old) | Gender (% women) |
|---|---|---|---|
| **PreP** = Pre-service teachers in Primary Schools | 54 | 23 | 88.9 % |
| **PreB** = Pre-service Biology teachers (Secondary) | 51 | 23 | 88.2 % |
| **PreL** = Pre-service Language teachers (Secondary) | 48 | 23 | 85.4 % |
| **InP** = In-service teachers in Primary Schools | 57 | 40 | 96.5 % |
| **InB** = In-service Biology teachers (Secondary) | 51 | 39 | 92.2 % |
| **InL** = In-service Language teachers (Secondary) | 61 | 39 | 90.2 % |

***Table 1*** *- The samples of Polish teachers who filled out the questionnaire*

### *2-2 - Questionnaire*

It was built during the two first years of the Biohead-Citizen project, taking several precautions which are described in an other work (Clément & Carvalho 2007): using first a pilot test and interviews, avoiding bias in translation, …

The final questionnaire includes 144 questions. The 29 questions related to Environment and Environmental Education are listed below, topic by topic

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **A1.** | We must set aside areas to protect endangered species. | I agree | | | | | I don't agree |
| **A5.** | If an intensive chicken farm were going to be created near where you live, you would be against this because it may pollute the groundwater. | I agree | | | | | I don't agree |
| **A7.** | Humans will die out if we don't live in harmony with nature. | I agree | | | | | I don't agree |
| **A11.** | Industrial smoke from chimneys makes me angry. | I agree | | | | | I don't agree |
| **A22.** | I enjoy trips to the countryside. | I agree | | | | | I don't agree |
| **A28.** | It makes me sad to see the countryside taken over by building sites. | I agree | | | | | I don't agree |
| **A40.** | It is interesting to know what kinds of animals live in ponds or rivers. | I agree | | | | | I don't agree |
| **A50.** | All contemporary plant species should be preserved because they may help in the discovery of new medicines. | I agree | | | | | I don't agree |

***Table 2 -*** *The questions related to the pole "Preservation (ecolocentric conceptions)*

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **A4.** | Nature is always able to restore itself. | I agree | | | | | I don't agree |
| **A8.** | People worry too much about pollution. | I agree | | | | | I don't agree |
| **A16.** | Our planet has unlimited natural resources. | I agree | | | | | I don't agree |
| **A17.** | Society will continue to solve even the biggest environmental problems. | I agree | | | | | I don't agree |
| **A18.** | Human beings are more important than other living beings. | I agree | | | | | I don't agree |
| **A23.** | We need to clear forests to increase agricultural areas. | I agree | | | | | I don't agree |
| **A32.** | Humans have the right to change nature as they see fit. | I agree | | | | | I don't agree |
| **A54.** | Only plants and animals of economical importance need to be protected. | I agree | | | | | I don't agree |

***Tableau 3 -*** *The questions related to the pole "Utilisation" (anthropocentric conceptions)*

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **A12.** | Genetically modified plants will help to reduce famine in the world. | I agree | | | | | I don't agree |
| **A13.** | Genetically modified organisms are contrary to nature. | I agree | | | | | I don't agree |
| **A39.** | Genetically modified plants are good for the environment because their cultivation will reduce the use of chemical pesticides (e.g. insecticides, herbicides). | I agree | | | | | I don't agree |
| **A47.** | Genetically modified plants are harmful to the environment because they will contaminate other crop plants, menacing their survival. | I agree | | | | | I don't agree |
| **A49.** | If a person eats genetically modified plants, his/her genes can be modified. | I agree | | | | | I don't agree |

***Table 4 -*** *The questions related to the pole GMO (Genetically Modified Organisms)*

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **A10.** | Snails are able to feel happiness. | I agree | | | | | I don't agree |
| **A29.** | Frogs are able to feel happiness. | I agree | | | | | I don't agree |
| **A45.** | Flies are able to feel happiness. | I agree | | | | | I don't agree |

***Table 5 -*** *The questions related to feelings of animals (sentimentocentred pole)*

In the first questionnaire used for the pilot test, there was 18 questions related to the feelings of animals : 6 animals with, for each, their ability to have feelings, to be happy and to feel dolour. There was a so strong correlation between feelings, dolour and happiness that we decides to use only one of these three categories. We reduced also the number of animals because 100% of the teachers had the same answer for animals as dogs or monkeys. When we know in advance the answers, it is useless to maintain the questions.

The last questions are dealing with practices related to environment, as the questions A56 (below), and to Environmental education, as the question A61.

**A56. There is a decision-making process in the implementation of science applications related to environment and biotechnology. Indicate, in each line, your degree of confidence in different actors to make such decisions** (tick only **ONE** case for each line):

| | | | | | |
|---|---|---|---|---|---|
| Scientists | | | | | Members of Parliament |
| Science experts of this specific field | | | | | Science experts of diverse fields including ethics |
| All the citizens (referendum) | | | | | Elected persons representing citizens at the national, regional or local levels |

**A61**. **In your opinion, the main goal of environmental education in school should be** (tick only **ONE** of the four boxes)**:**

| | | | | | |
|---|---|---|---|---|---|
| Providing knowledge | | | | | Developing responsible behaviour |

### *2-3 - How the questionnaire has been filled out*

All the teachers had to individually filled out the 144 questions of the questionnaire (10 pages), with a total guarantee of anonymity. It took between 30 to 45 minutes.
It was at the end of a course for the pre-service teachers, and in their school for the in-service teachers.

### *2-4 - Analysis of data*

The Polish team put the data on an Excel table, then analysed by the French team and collectively discussed by E-mail and during the Meeting of Budapest (February 2008).
We used multivariate analysis which are described in other works (Munoz & Clément 2007, Munoz et al 2009) mainly PCA and between analyses completed by randomization tests (Monte Carlo type): (Lebreton, Sabatier, Banco, and Bacou, 1991), Dray *et al.*, 2003; Dolédec & Chessel, 1994

## 3 - Results

### *3-1. PCA (Principal Components Analysis)*

The main component structuring the differences of Polish teachers' conceptions is related to the feelings of animals (Component 1 = horizontal axis in the figure 1). Any teacher answered in the same way for the 3 animals, with important differences among the teachers, as shown in the table 6. About one third of them agree or rather agree that snails, flies or frogs are able to feel happiness.

| These animals are able to feel happiness | I agree | I rather agree | I rather don't agree | I don't agree |
|---|---|---|---|---|
| Snails | 11.9% | 23.5% | 29.6% | 35.0% |
| Frogs | 11.3% | 24.1% | 29.3% | 35.4% |
| Flies | 10.3% | 17.4% | 28.0% | 44.4% |

***Table 6 -*** *Answers to the 3 questions related to the feelings of animals*

The second principal component structuring the differences among the Polish teachers conceptions is related to the GMO, with a strong opposition between pro- and anti-GMO opinions (vertical axis of the figure 1a). There is here also a great coherence of the teachers'

answers to these 5 questions, with nevertheless an exception for the question A13 ("Genetically modified organisms are contrary to nature"): a large part of anti-GMO answers for the other questions agree with this proposition, which mainly deals with values (table 7).

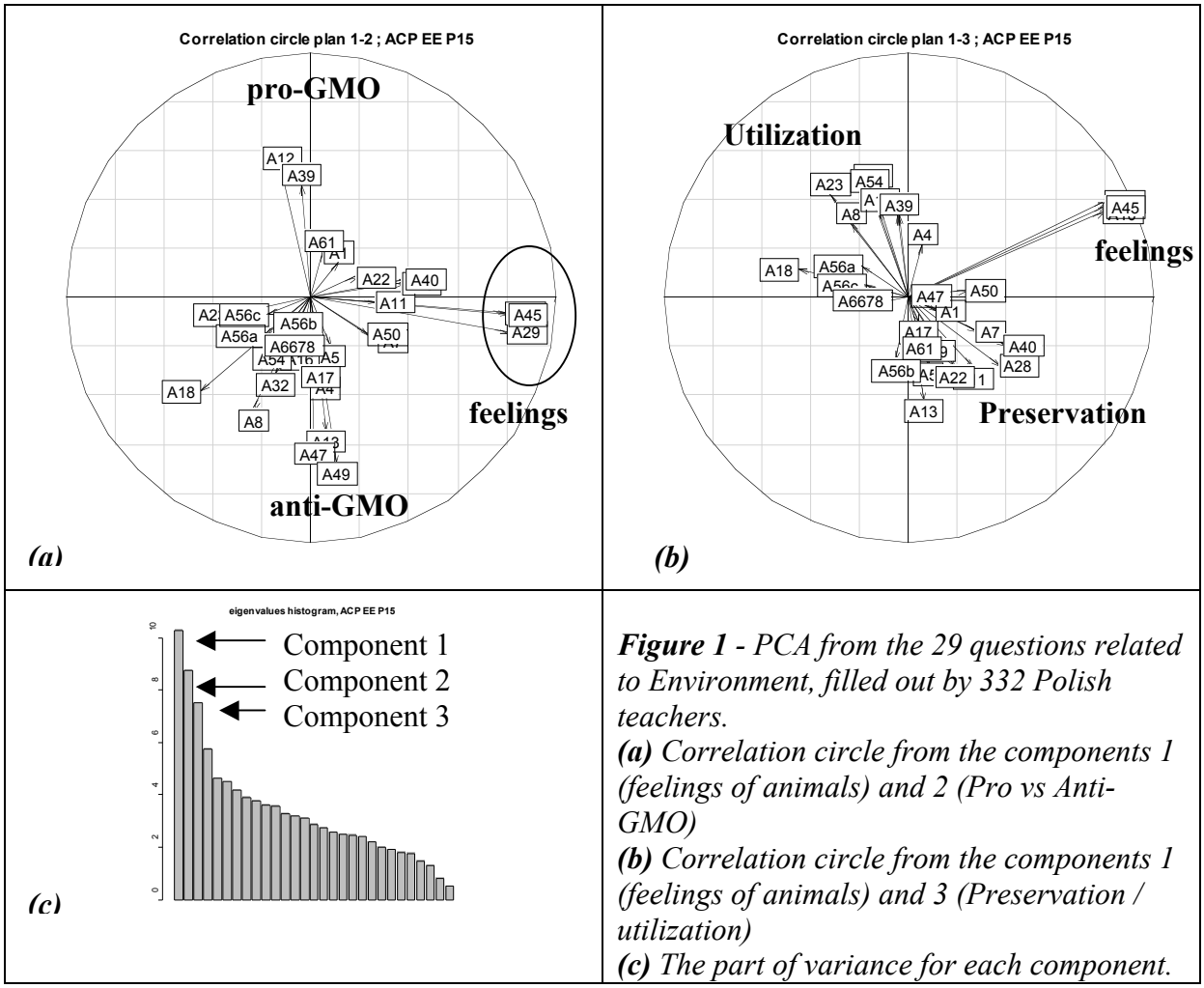


***Figure 1*** *- PCA from the 29 questions related to Environment, filled out by 332 Polish teachers.*
***(a)*** *Correlation circle from the components 1 (feelings of animals) and 2 (Pro vs Anti-GMO)*
***(b)*** *Correlation circle from the components 1 (feelings of animals) and 3 (Preservation / utilization)*
***(c)*** *The part of variance for each component.*

| | Anti-GMO | Rather anti- | Rather pro- | Pro-GMO |
|---|---|---|---|---|
| A49 | 15.8% | 20.6% | 30.2% | 33.4% |
| A47 | 19.0% | 25.7% | 36.0% | 19.3% |
| A13 | 43.7% | 28.9% | 19.9% | 7.4% |
| Inverse of A12 | 14.1% | 24.4% | 26.4% | 35.0% |
| Inverse of A39 | 13.8% | 22.8% | 31.5% | 31.8% |

***Table 7 -*** *Answers to the 3 questions related to the feelings of animals*

Globally, about the two third of Polish teachers are in favour to GMO, thinking that they "will help to reduce famine in the world" (A12), that they are "good for environment because their cultivation will reduce the use of chemical pesticides (e.g. insecticides, herbicides)" (A39),

and disagreeing that "Genetically modified plants are harmful to the environment because they will contaminate other crop plants, menacing their survival" (A47). These 3 questions were dealing with interaction between knowledge, values and the social use of GMO, showing the importance of this last aspect for the Polish teachers.

An interesting point is emerging from the answers to the question A49 ("If a person eats genetically modified plants, his/her genes can be modified"). That was a question of only scientific knowledge : it is known that it is not truth, even if the consequence of using GMO as human food is still today very debated. Nevertheless, the answers to this question are closely correlated to the answers of the 3 precedent questions, showing that the "knowledge" of teachers is mainly induced by their conviction pro- or anti-GMO.

The two first components are orthogonal (axes 1 and 2 in the figure 1a), showing an independence between these two sets of conceptions. Being pro- or anti-GMO, the teachers think that animals as snails, flies and frogs can or cannot feel happiness. Thinking that these animals can (or cannot) feel happiness, the teachers can be pro- or anti-GMO.

The third component structuring the Polish teachers conceptions is the vertical axis of the figure 1b, opposing answers for the preservation of environment to the answers for its utilization. When only these questions are analysed (Wiseman & Bogner 2003, Munoz et al. 2009), there is an independence between the pole preservation and the pole utilization. Here, these two poles are in opposition, teachers more agreeing with preservation are more disagreeing with utilization and reciprocally: nevertheless with a little less coherence in their answers than for the two first components of their conceptions (figure 1b).

Nevertheless, there is a great sensitivity of Polish teachers for the preservation of environment: 84.6% of them totally disagree with the proposition "We need to clear forests to increase agricultural areas" (question A23), and 75.9% with the proposition "Only plants and animals of economical importance need to be protected" (question A54). The same teachers are "enjoying trips to the countryside" (89.1% of I agree for the question A22) and most of them (45.7% agreeing and 33.1% rather agreeing with the proposition "It makes me sad to see the countryside taken over by building sites" (question A28), to take only some examples of answers. This relative homogeneity of Polish teachers' conceptions for the preservation of environment explains that this topic is only the third component explaining the difference among their conceptions on Environment, the main differences coming from the two first components (animals feel or not happiness, and pro- or anit-GMO).

### *3-2. Between analyses to differentiate groups of Polish teachers*

There is no significant difference between teachers when they are grouped from their gender, their age or their level of qualification.

Nevertheless, there is a significant difference ($p<0.001$ figure 2d) when we compare the six samples described in the table 1 (figure 2). This difference is linked to the questions dealing with GMO, opposing the biology teachers (PreB and InB) to the other teachers (figure 2c and 2f). The biology teachers more agree than their colleague with the proposition A39 ("Genetically modified plants are good for the environment because their cultivation will reduce the use of chemical pesticides (e.g. insecticides, herbicides))", and with the proposition A12 ("Genetically modified plants will help to reduce famine in the world"). They more disagree than their colleagues with the propositions A13 ("Genetically modified organisms are contrary to nature") and A49 ("If a person eats genetically modified plants, his/her genes can be modified"). That means that they are more in favour with GMO than their colleagues, knowing better than them that our genes are not modified when eating GMO (A49) but also from opinions more dealing with values (A13: for them the GMO are less contrary to nature) and dealing with interaction between knowledge and values for the controversial questions A39 and A12.

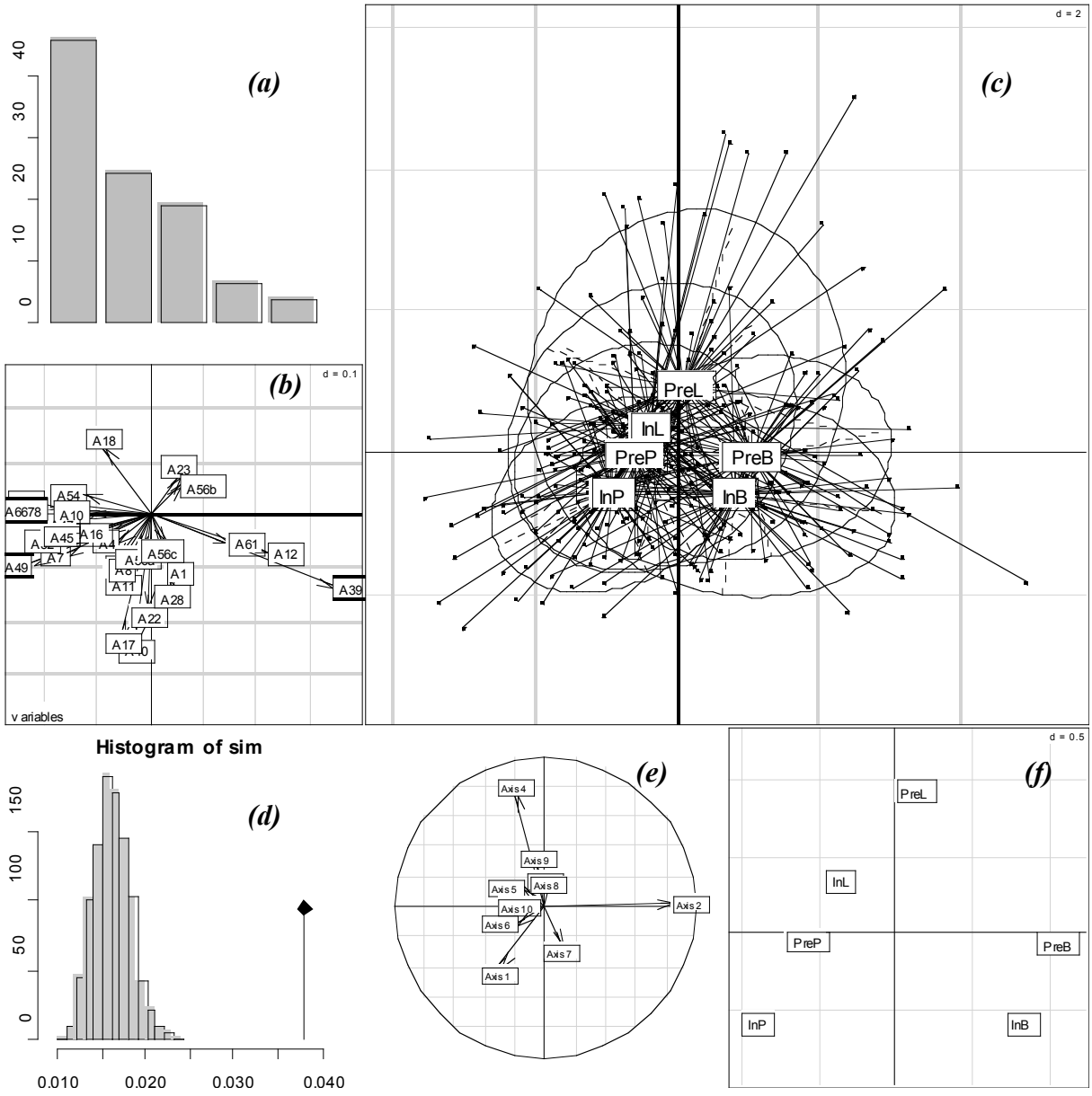


***Figure 2 -*** *Between analysis differentiating the six samples of teachers.*
***(a)*** *Part of variance explained by the different components. The first one is the most important.*
***(b)*** *Circle of correlation showing that the questions which differentiate the 6 samples are dealing to GMO, mainly the question A39.*
***(c)*** *Each point is corresponding to one teacher's answers, joined to the centre of gravity of its group (the 6 samples described in the table 1). Each ellipse encompass 2/3 of each sample.*
***(d)*** *The test of randomization (Monte Carlo) shows that the observed difference is outside the histogram coming from 1000 essays by random: the difference between the 6 samples is significant ($p<0.001$).*
***(e)*** *Correspondence between the axes of the initial PCA 'figure 1) and the axes of this between analysis: its horizontal axis is corresponding to the axis 2 of the PCA, dealing with GMO.*
***(f)*** *Enlargement of the graph (c ), with only the centres of gravity of the 6 samples.*

### *3-3. Between analyses to differentiate Polish teachers from teachers of other European countries.*

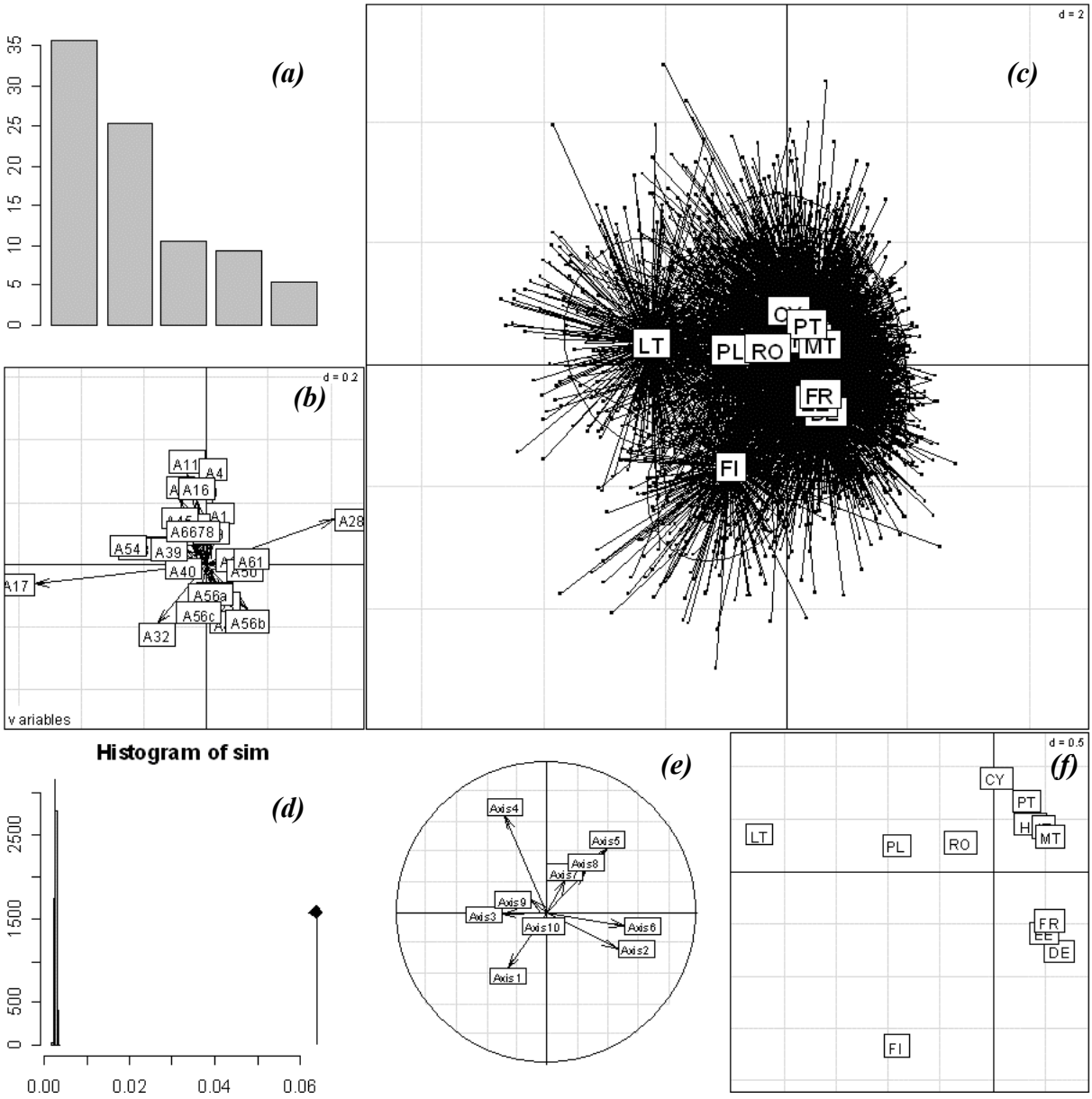


***Figure 3 -*** *Between analysis differentiating the Polish teachers to teachers from other European countries: (from left to right of the horizontal axis) LT = Lithuania, FI = Finland, RO = Romania, CY = Cyprus, PT = Portugal, HU = Hungary, IT (hidden by MT) = Italy, MT = Malta, EE (hidden by FR) = Estonia, FR = France, DE = Germany.*
***(a)*** *Part of variance explained by the different components.* ***(b)*** *Circle of correlation showing the questions which differentiate the 13 countries.* ***(c)*** *Each point is corresponding to one teacher's answers, joined to the centre of gravity of its country. Each ellipse encompass 2/3 of each country.* ***(d)*** *The test of randomization (Monte Carlo) shows that the observed difference is outside the histogram coming from 1000 essays by random ($p<0.001$).*
***(e)*** *Correspondence between the axes of the initial PCA from these countries and the axes of this between analysis* ***(f)*** *Enlargement of the graph (c ), with only the centres of gravity of the 13 countries.*

The figures 3 shows that the teachers' conceptions on environment differ from a country to another, the main differences being along the horizontal axis, with the opposition between Lithuania, and also Poland and Finland, to the other European countries (Romania and Cyprus being in the middle). The questions which support this opposition are, by order of importance: mostly A17 and A28, then also A54, A18 and A32. Teachers from Lithuania, and at a little degree from Poland and Finland, think more than their colleagues from other countries that "Society will continue to solve even the biggest environmental problems" (A17); and think less than the others that "It makes (them) sad to see the countryside taken over by building sites" (A28). These conceptions are correlated with other more anthropocentric conceptions, agreeing with "Only plants and animals of economical importance need to be protected" (A54), " Human beings are more important than other living beings" (A18) and "Humans have the right to change nature as they see fit" (A32).

The table 8 shows the differences between 4 of the 12 countries for the question A17. At one pole (more ecolocentric and for preservation) is Germany, France being very near. At the other pole (anthropocentric, more for utilization) is Lithuania and, in the middle, Poland. In Lithuania and in Poland, teachers are more optimistic than most of their colleagues of other European countries, believing more that our society will be able to solve the biggest environmental problems. We hope they will be right, and that our research on teachers' conceptions related to Environment will help to improve scientific education to take decisions in this direction.

| ***Question A17*** | I agree | Rather agree | Rather don't agree | I don't agree |
|---|---|---|---|---|
| Lithuania (n = 316) | 83.9% | 13.0% | 1.6% | 1.6% |
| **Poland (n = 322)** | **31.8%** | **33.1%** | **23.2%** | **11.9%** |
| France (n = 732) | 6.4% | 18.9% | 40.3% | 34.4% |
| Germany (n = 365) | 1.9% | 6.8% | 40.3% | 51.0% |

***Table 8 -*** *Answers to the questions A17 in Poland and in France.*
*A17 : "Society will continue to solve even the biggest environmental problems"*

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